CONSIDERATIONS ON THE IMPLICATIONS OF ENVIRONMENTAL INFORMATION SYSTEMS IN HYDRO-METEOROLOGICAL FORECAST

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ABSTRACT. – Considerations on the implications of Environmental Information Systems (EISs) in hydro-meteorological forecast. The present era that we are living can be described as the "Information Age". No matter what area of science and technology we look at, it is more obvious that ever that we are dealing with an 'information overflow' without precedent in the history of humanity.
In this context, Environment Sciences are no exception and recent advances in this field would have been unthinkable, unmanageable and unattainable without the support offered by modern information technology, in the sense of Environment Information Systems or, why not, Environment Informatics.
The aim of the present paper is to introduce and to underline the importance of Environment Information Systems, especially in solving many environments problems, such as the problematic issues reclaimed by the hydrometeorology area. In addition, the present paper describes the possibilities to implement different software specialized in evaluation, forecasting and monitoring, in the context of complex area defined by environment protection and engineering and conditioned by the dynamics of hydrology and meteorology with a view focused on the environmental information.

Keywords: Environmental Information Systems, hydrometeorology, Environmental Informatics.

1. INTRODUCTION

Hydrometeorology is a branch of meteorology that deals with problems involving the hydrologic cycle, the water budget and the rainfall statistics of storms. The boundaries of hydrometeorology (Castronova et all, 2010) are not clear-cut, so the problems of the hydrometeorologist overlap with those of the climatologist, the hydrologist, the cloud physicist and the weather forecaster, and nowadays, more than ever, with the informaticians abordations.

Considerable emphasis is placed on determining, theoretically or empirically, the relationships between meteorological variables and the maximum precipitation reaching the ground. These analyses often serve as the bases for the design of flood-control and water-usage structures, primarily dams and reservoirs.

Other concerns of hydrometeorologists include the determination of rainfall probabilities, the space and time distribution of rainfall and evaporation, the recurrence interval of major storms, snow melt and runoff, and probable wind

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tides and waves in reservoirs. The whole field of water quality and supply is of growing importance in hydrometeorology and also in the sector of environmental information systems.

Hydrometeorological science (Giurma, 2003) has made strong progress over the last decade at the European and worldwide level, and in these conditions appears new modeling tools, post processing methodologies and observational data. Recent European efforts in developing a platform for e-science provide an ideal basis for the sharing of complex hydrometeorological data sets and tools. Despite these early initiatives, however, the awareness of the potential of the Grid technology as a catalyst for future hydrometeorological research (HMR) is still low and both the adoption and the exploitation have astonishingly been slow, not only within individual EC member states, but also on an European scale.

Lately, special attention was given to research, management and control issues whether we refer to environmental pollution, as a whole, whether we talk about risks (hazards) technological or natural and all disturbing elements to the dynamic equilibrium of the environment or with a degree or another of acceptability for the population.

For the development of hydrological forecasts, the necessary basic data are collected the field devices via a network of meteorological and hydrological characteristic points located in the river basins (Podani et all, 2001). These data are transmitted to the dispatcher center where are processed resulting the real characteristics of floods.

At the dispatcher center arrive also recorded data on hydraulic structures in the area and after processing, resulting their influence on the hydrological regime. Having available all the data collected, the dispatcher center sets to reach the optimal commands hydro-technical constructions and protection measures required in various sections of the river network.

Therefore, construction of a hydro-technical basin shall be the source of information for the hydrologic flow regime changed and beneficiaries of hydrological forecasts for optimal and safe operation.

In establishing the basic hydrological forecasts, we have the following objectives:

- Determine the data to be measured and collected, including the information from hydro-technical works amending the flow regime;
- Establishment of computational methods, including the mathematical modeling operational;
- The endowment with the adequate computer equipment;
- Ensuring a reliable informational system;
- Ensuring the defense plans and operating regulations for taking of appropriate measures;
- The achievement of hydro-technical works allowing rapidly maneuvers drain and tributary flow exhaust.

The hydrological prognosis is, in principle, through modeling, which is a research path of complex phenomena. Application of hydrological models could have physical or mathematical dominant composition, as follows:

- Representing the laws of the basin hydrologic (rainfall-runoff models) used for forecasting and generalizations;
- Chronological simulation data strings to complete the measurements and observations of short duration, to which is added the transfer information, and extrapolation and interpolation of hydrological temporal and spatial parameters.

Another type of forecasting, which requires a detailed research and enjoys particular attention to, is the long-term hydro-meteorological forecast. This may be based on water reserves of the basin, the water supply network of riverbeds or established statistical methods foundation is laid on.

2. WARNINGS AND HYDROMETEOROLOGICAL FORECASTS

Prediction of floods and other hydrometeorological events relies on hydrological and meteorological forecast models that solve the basic equations that describe the hydrological cycle in the atmosphere (Giurma, 2003). These predictions are based on observational measurements, for example of rainfall and river flow.

In recent years, the quantity and complexity of the tools and data sets has increased dramatically for three reasons. Firstly, remote sensing observations from satellites and from ground-based radars provide complete three-dimensional coverage of the atmospheric and land surface state, vastly increasing the quantity of data. Secondly, forecasting methods combine multiple numerical weather prediction and hydrological models through stochastic downscaling techniques to quantify the uncertainty in the forecast; which, in this case, multiplies the computational costs. Thirdly, there is increased recognition of the need to understand the entire forecasting chain, from observations through to civil defense response, resulting in complex workflows able to combine different data sets, models and expertise in a flexible manner, been unthinkable, unmanageable and unattainable without the support offered by modern information technology, in the sense of Environment Information Systems or, why not, Environment Informatics. .

All the observations, forecasting methods and other prediction and hydrometeorological methods and models combine in a sense or another tools given by Envionmental Informatics [16] and develop a new science of perspective, named Hydrometeo-Informatics.

Hydro-Meteorological Research is closely linked to operational forecasting. Researchers rely on data archives maintained by operational agencies and increasingly make use of operational modeling tools (D'Agostino et all, 2010). The scattering of hydrometeorological data tools among national operational agencies and ad hoc collections from fields' campaign is a substantial barrier to

progress in research. On the one hand, weather systems freely cross national boundaries, and thus the national archives are of limited use.

Although the hydro-meteorological quantities randomized in nature, they presents some cycles that can also be highlighted by a careful analysis of the available data samples (Giurma, 2003). There are encountered so the millenary cycles, the secular and annual ones (the millenary and secular values exceeding the length of recorded samples, shall be considered less known). For the hydro-meteorological annual values were observed cycles of 30, 11 and 7 years, which requires the observation that a very rainy year characterized by high flows is not followed quickly by a very dry year, usually occurring 4-5 years rainy sequences followed by 4-5 years of drought (Giurma, 2003). Based on these findings and carefully analyzing the measurements and observations resulting in the basin and the various methods of statistical analysis, we anticipate the character of the following year based on previous years, especially under the impact of computer science and Environmental Information Systems (EISs) [18] for environmental data management.

Hydro-meteorological forecasting organization generally includes the following elements: operational hydro-meteorological forecasting information (dissemination), organization and technical information system as well as obtain the information necessary to establish the forecast bulletin. Briefings on the current situation and that of the last 24 hours, and prognosis on the following 1-3 days are made daily. In addition (Şelărescu el all, 1993), warnings shall be emitted every time necessary, even several times per day and some phases of the flow regime, such as spring floods, low water summer-autumn or winter, shall be expected over time anticipation, 1-3 months in advance.

3. THE IMPLICATIONS OF ENVIRONMENTAL INFORMATION SYSTEMS IN DEVELOPMENT AND DISSEMINATION OF HYDRO-METEOROLOGICAL FORECASTS

3.1. The technique of obtaining hydro-meteorological data

Measurement at the points of, the data are obtained using non-automated and automated processes media (Giurma, 2003). Non-automated resources are common and include the bridegroom, limnigraphes, hydrometers, thermometers, pluviometers, pluviographes. Resources shall be automated stations equipped with sensors to measure rainfall and temperature main and stations equipped with sensors to measure water levels, rainfall and temperature.

Besides the main sensors at these stations can add sensors to measure other hydro-meteorological factors such as humidity, atmospheric pressure, wind direction and speed, the sunshines, the water equivalent of snow, etc.

Stations are measured at times scheduled by the collection, query cycle is adjustable between 15 minutes and 6 hours to the needs dictated by general hydro-meteorological conditions.

Basic means of systematic dissemination of hydro-meteorological information and forecasts are daily hydro-meteorological bulletin, but besides this, there are special situations or restricted areas, and in this case, we need a special hydro-meteorological bulletin.

3.2. The Environmental Information System (WIS) and classifying information in this area

The Environmental Information System (EIS) consists therefore of all means of collection, transfer, processing and verification of information in the decision-water resources of hardware known as well as all procedures, programs and information processing software, programs related-known means of software.

Water Information System, as part of the EIS, include the classic, established based on human operators and automated water information system based on the - component calculation.

The concept of information flow in the water includes all ways of gathering, transmission, processing and utilization of information as well as content and frequency.

Such information is divided into two categories (Giurma, 2003):

- slow flow or statistical information;
- fast or operators information flow in real time.

Shall be used in decision-making both types of information. Much of the information flow becomes faster recovery after slow flow information and is stored in so-called statistical databases and others that are not needed in decision-making disappear after a preset time. Collection, compilation, processing and use of information decision scope selected from water are through specialized units called, “dispatching of the waters” with skills in line with the country's territorial administrative organization.

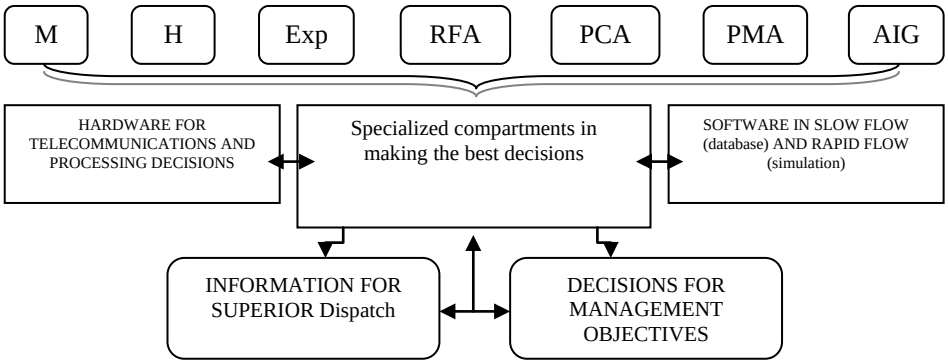

Fig. 1.The scheme of water dispatcher funtioning (Giurma, 2003)

The input information are characterized by the following categories of data: meteorological (M), hydrological (H), data exploitation of hydrotechnical works (Exp), issues relating to regulation of water uses (RFA), the protection of

water quality data (PCA), environmental protection (PMA), protection against floods and ice (AIG) (Giurma, 2003).

The main products of the dispatch information refer to the selection of the higher dispatcher information and decide for dispatcher from managed targets, which shall be added and establish decision-making skills at different levels - which appears to be one of the most complex operations managerial.

In Europe, according to the implication of EIS in hydrometeorology as WIS, a large number of hydrometeorology research projects have been financed by the European Commission in the last years. Although some of these projects overlap in parts with the idea of an HMR Grid, their focus was completely different, as well as the various and multidimensional implications of EISs as it follows:

- HyMeX (Hydrological cycle in the Mediterranean eXperiment, [9]) aims at better understanding and quantifying the hydrological cycles and processes in the Mediterranean, with special emphasis on high-impact weather events, interannual to decadal variability of the Mediterranean system and associated trends in the context of global change;
- FLOODsite (Integrated Flood Risk Analysis and Management Methodologies, [10]) covers the physical, environmental, ecological and socio-economic aspects of floods from rivers, estuaries and the sea. It considers flood risk as a combination of hazard sources, pathways and the consequences of flooding on people, properties and the environment;
- IMPRINTS (Improving Preparedness and Risk maNagemenT for flash floods and debriS flow events, [11]) contributes to the reduction of loss of life and economic damage through the improvement of the preparedness and the operational risk management of flash flood and debris flow generating events, as well as contributing to sustainable development through reducing damages to the environment;
- MAP-D-PHASE (Mesoscale Alpine Programme – Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events) demonstrates some of the many achievements of the Mesoscale Alpine Programme (MAP), in particular the ability of forecasting heavy precipitation and related flooding events in the Alpine region. It addressed the entire forecasting chain ranging from limited-area ensemble forecasting, high-resolution atmospheric modeling (km-scale), hydrological modeling, and nowcasting to decision making by the end users, by setting up an end-to-end forecasting system.
- FP6 PREVIEW (Prevention Information and Early Warning, [12]) was looking for new techniques to better protect European citizens against environmental risks and to reduce their consequences;
- CLIVAR (CLImate VARiability and predictability: a programme of the World Climate Research Programme, [19]) develops a better understanding of climate variability and applies this to provide useful

prediction of climate variability and change through the use of improved climate models;

- COST 731 (Propagation of uncertainty in advanced meteo-hydrological forecast systems, [17]) addresses issues associated with the quality and uncertainty of meteorological observations from remote sensing and other potentially valuable instrumentation, as well as their impacts on hydro-meteorological outputs from advanced forecasting systems;
- FloodProBE (Flood Protection of the Built Environment – Technologies for Improved Safety of the Built Environment in Relation to Flood Events, [20]) develops technologies, methods and tools for flood risk assessment and for the practical adaptation of new and existing buildings, infrastructure and flood defenses leading to a better understanding of vulnerability, flood resilience and defense performance.

4. CONCLUSIONS

The present era that we are living can be described as the "Information Age". No matter what area of science and technology we look at, it is more obvious that ever that we are dealing with an 'information overflow' without precedent in the history of humanity [18].

In this context, the importance of Environment Information Systems [14], especially in solving many environments problems, such as the problematic issues reclaimed by the hydrometeorology area (prediction, prognoses, modelling and simulation models of floods (Quarati et all, 2011), information dissemination to the public etc) (Şelărescu et all, 1993) is more than vital, because all this aspects must be integrated with the elements related to sustainable development such as environment protection and human health and safety or security.

Meteorologists, hydrologists and engineers have long recognized the value of hydro meteorological data and more importantly the rainfall data for hydrologic analyses (Podani et all, 2001). Thus, application and analysis of meteorological data for the solution of hydrologic problems has precisely come to be known as the science of hydrometeorology.

In a broad sense, hydrometeorology is a borderline science linking meteorology - the science of atmosphere - with hydrology - the science of water of the earth and earth's atmosphere.

In engineering hydrology dealing with design and operation of water resource projects, the subject of hydrometeorology occupies a central position. Obviously, the importance of the subject of hydrometeorology has become increasingly recognized (Rao et all, 2006) and it is now studied not only by hydrologists and engineers but also by students from many different disciplines, with the help given by the tools develop in this sense, tools that make the importance of Environmental Information Systems to be vital in the context of applied hydrometeorology.

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